An Archaeoastronomical Investigation: Does a Constellation Pattern Appear in Rapanui Rock Art?

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INTRODUCTION

KRUPP (1997) BROADLY DEFINES the interdisciplinary field of archaeoastronomy as embracing "calendrics; practical observation; sky lore and celestial myth; symbolic representation of celestial objects, concepts, and events; astronomical orientation of tombs, temples, shrines, and urban centers;" and other, similar trappings of culture. While some of these aspects might better be classified as "ethnoastronomy," it remains a useful definition.

The archaeoastronomy of Rapa Nui largely has dealt with the "astronomical orientations" (alignments) of *ahu* (*i.e.*, the seminal work summarized by Liller 1989). This is in keeping with the modern tradition of archaeoastronomy that began with analyses of megalithic stone circles in Western Europe (*e.g.*, Stonehenge). (See Ruggles 1999 for a detailed history of archaeoastronomy.) Here, we wish to discuss the possible "symbolic representation of celestial objects" in rock art, a task pioneered in the American Southwest by scholars such as Von del Chamberlain, Steve McCluskey, and Ray Williamson.

There exists ethnographic evidence for Rapanui depictions of the sky, the first recorded being that of Routledge (1919). Rapanui interest in *Matariki*, which refers specifically to the Pleiades but might more generally indicate constellations of stars, has been noted by dozens of investigators from the nineteenth century onward (*e. g.*, Van Tilberg 1994). In addition, Lee (1992) and Liller (1989) have found petroglyphs that clearly resemble a comet.

To our knowledge, no one has pointed out an unambiguous constellation, or significant portion of a constellation, in extant Rapanui rock art. While there are allusions to the Pleiades, no pictogram, petroglyph, or set of stones has been identified as *being* the Pleiades. Even so, Lee, in her comprehensive documentation of Rapanui rock art (1992), has encountered contemporary informants who attach astronomical significance to certain patterns within the ubiquitous cupules (circular depressions pecked and abraded on rock throughout the island). It is one such site that we investigate in this paper.

FIELD WORK

The "matariki stone" (from here used without quotation marks) examined in this work is a multi-faceted, fine-grained basalt boulder, approximately 1 m x 1.5 m x 2 m in size. Its weight is estimated to exceed 10,000 kg. The boulder has sustained a large crack.

At least six cupules have been placed in the boulder, averaging 6 cm in diameter and 5 cm in depth. The crack destroys the spatial relationship between cupules on either side. Those on the east side were used in this analysis.

The boulder is now sitting in the yard of a private residence in the Mataveri section of Hanga Roa, west of the Hotel Iorana. Information about its original setting, orientation, and context (provided by other nearby artifacts) is lost. Likewise, it is not possible to use even the inexact dating techniques sometimes applied to petroglyphs. (The current residents of the property can provide no historical information about the boulder, other than that it has attracted the attention of modern visitors.)

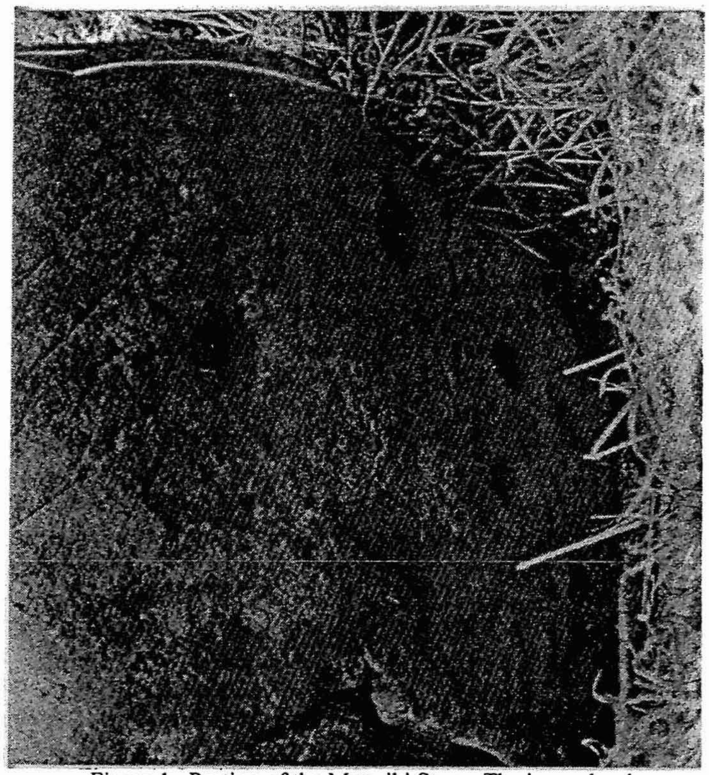

Figure 1. Portion of the Matariki Stone. The image has been rotated 90° to show the cupule pattern (Courtesy of Georgia Lee).

We are left, then, with but the pattern itself. Does it bear a likeness to any star patterns visible from Rapa Nui? A difficulty encountered with celestial-pattern recognition is that any three stars form a triangle. That is, there is little to distinguish stars from each other besides position in the sky. (Stars are featureless points on the Celestial Sphere; there is nothing to suggest that stellar magnitude or color was meant to be portrayed in pet-

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roglyphs.) Still, a data set of n=6 is great enough to provide, at least, the hope of pattern identification, if there is indeed a naturalistic, representational arrangement, and if it is indeed celestial.

We do not mean to suggest that the set of cupules might be a *map* of stars: Pre-contact Rapanui technology does not provide the precise angular measurement required. Instead, our search is for an *artistic* interpretation, with all the potential utilities (ceremony, aesthetics, commemoration, *etc.*) motivating human artistic expression.

ANALYSIS

Photographs of the matariki stone, taken *in situ*, were digitized. The present orientation of the stone leads to what is presumably a distortion of the intended pattern from any available viewing angle. Because the intended viewing angle is unknown, we did not attempt any three-dimensional rotation of the digitized image. Doing so would introduce several more free variables and increase the likelihood of a false-positive pattern recognition.

The centers of the cupules were tagged, based on the locations of cupule rims and shadows. The resulting diagram was compared to a computer simulation of the night sky as seen from the latitude of Rapa Nui (Lane 1996).

The night-adapted naked eye, under dark, moonless skies at sea level, may discern stars as faint as magnitude 6. (In the astronomical apparent-magnitude scale, increasing brightest corresponds to smaller numbers.) However, these conditions rarely exist on Rapa Nui, even in pre-historic times. It seems unlikely that magnitude 5 and 6 stars would have been rendered, without especially compelling reasons for doing so.

One documented exception to this is aboriginal peoples depicting the Pleiades, a group of faint-but-visible stars covering an unusually small angular extent in the sky. Yet the arrangement of cupules on the matariki stone in question does not resemble the Pleiades.

The simulated sky was surveyed using limiting magnitudes of 1, 2, 3, and 4. Western constellation boundaries and "stick-figure" connecting lines were eliminated from the simulation so as not to introduce a bias: The hypothesized matariki stone stars might not conform to any modern constellation. Rather, they might combine parts of multiple modern constellations.

Natural groupings of stars were searched for, under angular resolutions that portrayed (one at a time) five, minimally overlapping sections of the sky on a computer screen. These individual views may be referred to as the "North," "South," "East," West," and "Zenith" skies. We know of no pattern of stars in art, either ancient or modern, that attempts to link stars spread over large areas of the entire sky.

The magnitude 1 simulations were not very interesting; there are few stars in the sky of that magnitude. Even acknowledging the possible passage of a bright planet into a star field along the ecliptic, nothing resembling the matariki stone configuration was observed.

The magnitude 4 simulations were not useful for another reason: At that magnitude limit, there are simply too many stars. Identifying one particular pattern becomes hopeless.

Thus, we were left with magnitude 2 and 3 simulations. Two candidate star patterns were identified. Both were recognizable in magnitude 3 simulations. Note that there are approximately 114 stars on the Celestial Sphere, magnitude 3 or greater, visible from Rapa Nui.

The first candidate includes stars from the modern constellations Crux and Centaurus, which transit at altitude 60° in the Rapanui sky. One star in Crux—of comparable brightness to the others and necessary to form the familiar "cross" pattern—is missing from the artwork. Nevertheless, the present orientation of the boulder admits the possibility that the "missing" star is underneath. This candidate was exciting because of the stars' well-known use in identifying the South Celestial Pole (for purposes of celestial navigation).

After further consideration, the first candidate was discarded. The second candidate is more robust: It more closely matches the matariki pattern. It is a smaller grouping (15° in angular extent upon the sky). And it consists of one of the most distinctive patterns of bright stars in the South Celestial Hemisphere: the "teapot" asterism of Sagittarius.

All but one of the remaining stars of Sagittarius are fainter than magnitude 3. The spatial relation of the one exception (a magnitude 2.9 star, 7° away) is such that it conceivably could be represented by a cupule on the other side of the crack. The next nearest bright stars in the sky are in the constellation Scorpius.

Sagittarius does not present any horizon-proximity prob-

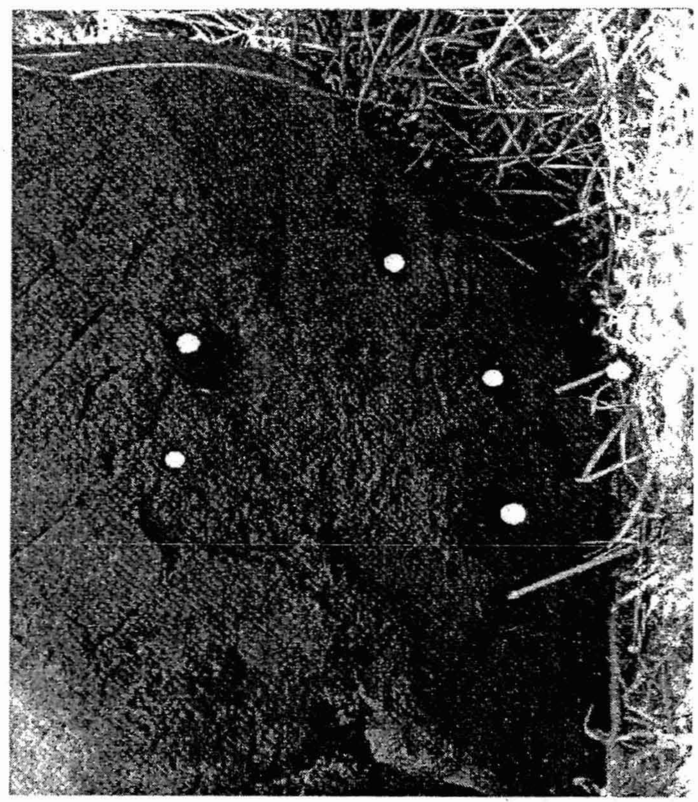

Figure 2. A Map of Sagittarius superimposed on the matariki stone..

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lems. From Rapa Nui, the constellation happens to pass through the *zenith*—that is, it can appear directly overhead. There are long intervals of time when it is far from the horizon.

Post hoc reasoning yields the following, other unique attributes of Sagittarius (Figure 3): Sagittarius culminates on the zenith at dusk on the vernal equinox (and, therefore, dawn on the autumnal equinox). Similarly, Sagittarius sets as the Sun rises on the winter solstice and, therefore, rises as the Sun rises at the summer solstice. Astronomical precession plays a small role over the time span of Rapanui civilization; still, a precessional correction for approximately 1500 CE improves the coincidental timing of these events over that of modern times.

Furthermore, Sagittarius is a zodiac constellation; bright planets may appear in it from time to time. Sagittarius also is in the direction of a particularly bright part of the Milky Way.[1]

Even without the view-point distortion, the relative positions of the matariki stone cupules are almost certainly not a one-to-one match with the proper angular positions for the Sagittarius stars. As stated before, there is no reason to assume that positional verisimilitude was an objective in producing this rock art. The accuracy is, though, similar to that displayed in some published, western star charts of the Middle Ages (contemporary with the Rapanui). (See North 1995 for examples.) Moreover, old-world uranographers had much easier media, drawing tools, and "studio environment" with which to work.

Identification of the matariki pattern ultimately rests on the authenticity of certain cupules and their concurrent manufacture. Cupule #5 differs in morphology from the others. While it is of

Figure 3. From an Eleventh-century Star Map by Al-Sufi. The relevant stars have been marked with open circles. (From the Bibliotecque Nationale de France at http://www.bnf.fr/web-bnf/

the same diameter, it is not as deep. It appears incomplete. If cupule #5 is natural to the boulder, or an earlier/later addition, the identification is compromised.

Is the matariki stone pattern a coincidence? Consider a circle of radius R (part of the rock face incorporating the pattern) completely within which are six, identical, non-overlapping circles of radius r. (These smaller circles represent the Sagittarius star positions to a given level of precision.)

The real boulder was not so much a *tabla Rasa*. Its surface topography surely influenced the finished rock art. This is a sound first-order approximation, though.

What is the probability, P, of six cupules being placed randomly such that one (and only one) falls into each of the smaller circles? The area of a circle is proportional to radius squared. If ρ is the ratio of the diameter of the large circle to that of the smaller circles, then

$$1/P = (\rho^2)(\rho^2-1)(\rho^2-2)(\rho^2-3)(\rho^2-4)(\rho^2-5)$$

The size of the cupules and their proximity to each other suggest that $\rho = 10$ is a reasonable assumption. Thus,

$$P = 1.165 \times 10^{-12}$$

Obviously, these statistics are for uncorrelated data points. We assume the cupules *are* correlated. Even if no pattern was intended, the fact that cupules are of finite size yet not superimposed introduces a correlation. Still, this exercise demonstrates the significance of the number of points involved.

Conclusion

The calendrical importance of zenith transits to inhabitants of low latitudes is well documented. (See, for instance, Aveni 1997.) Particular concern with the winter solstice is worldwide. Liller (1989) makes a convincing argument for architectural alignments on Rapa Nui marking the solstices or equinoxes.

Attention paid to the regions of the Milky Way is also universal, but it figures most prominently in the sky lore of South and Central America (Krupp 1991). By suggesting that the Rapanui watched Sagittarius and the Milky Way, we do not mean to imply any cultural connection between native American peoples and those of Polynesia. The Milky Way is really more spectacular the farther south one observes it. We propose, alternately, similar (but independent) astronomical awareness, demonstrated by civilizations at the same latitude.

Of course, the association of our matariki stone pattern with astronomical events must remain a hypothesis, because of the standard vagaries involved in rock-art interpretation, and because of the *ad hoc* nature of the hypothesis itself. Nonetheless, having entered into this exercise with pessimism about making any linkage between the matariki stone and any real star pattern, we find this hypothesized correlation heartening.

Future work should include 1) the discovery and identification of other star patterns in Rapanui rock art. While a single example by a single artist cannot be disproved, a statistical sample of hypothesized star-patterned rock art would help the analysis considerably.

2) The matariki stone under present consideration must be rotated so that the hypothesized figure can be viewed "face on" (as it was likely created and as the artist likely intended).

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This might be simulated with multi-axis image-rotating software. Otherwise, it might be done physically.[2]

3) Pattern-recognition software should be brought to bear, in order to eliminate human bias in identifying patterns, both celestial and in rock art. Such software exists, but it is tailored toward practical duplication (for example, fingerprints, handwriting, or counterfeit bills) and not to the needs of archeologists or astronomers.

4) A computer model should be constructed to more realistically ascertain the probability of random cupule placement resulting in "a Sagittarius," within some level of precision.

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FOOTNOTES

[1] A mystic once asked an author [TH] to compute the location from which he could stare in the direction of the Galactic center (while facing the zenith) on the instant of the summer solstice. The answer lay in the ocean. However, the nearest inhabited land was Rapa Nui.

[2] An author [AH] attempted to rotate the boulder—with permission!—while avoiding damage to its surface. Six adult Iowans, using a six-foot steel lever, changed the boulder's placement by 1-2 centimeters. This action was sufficient to allow insertion of two small wedges, thereby stabilizing the new orientation. It provided an only slightly better viewing angle.

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